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Research paper

Motivational factors influencing farming practices in northern Ghana

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ABSTRACT

Socio-economic factors that influence the adoption of management practices and technologies by farmers have received wide attention in the adoption literature, but the effects of socio-psychological farmer features such as perceptions and motivations have been analysed to a lesser extent. Using farm household survey data from three regions in northern Ghana, this study explores farmers' motivations and perceived adoption impediments for three sustainable intensification practices (SIPs): improved maize varieties, cropping system strategies, and combined SIPs (i.e. improved maize and cropping system strategies), and the effect of motivational factors on decisions to adopt SIPs. First, explorative factor analysis (EFA) was used in identifying factors of motivations and impediments for adoption of SIPs. Then, a multinomial logit model was used to analyze the effect of socio-economic farm characteristics and motivational factors on farmers' decisions to adopt SIPs. EFA identified three motivational factors: *personal satisfaction*, *eco-diversity* and *eco-efficiency*, which differed in importance between the three regions. Across these regions, higher scores for aspects of *personal satisfaction* were associated with lower interest in improved maize varieties compared to cropping system strategies, while the opposite was true for *eco-efficiency* which was related to a stronger preference for improved maize varieties. *Uncertainty*, *absence of social support*, and *resource constraints* were identified as impediment factors. The logit model demonstrated that extension services seemed to support the use of improved maize varieties more than the implementation of cropping system strategies. We conclude that motivational factors significantly influence farmer adoption decisions regarding sustainable intensification practices and should be considered systematically in combination with socio-economic farm features and external drivers to inform on-farm innovation processes and supporting policies.

1. Introduction

Investments into intensification of agriculture in sub-Saharan Africa (SSA) have resulted in increased production over the past years, but a 'green revolution' has not yet emerged (Dawson et al., 2016). Moreover, current gains may stand to be in danger because of rapid population growth, climate change, scarcity of resources such as land, water and energy (Pretty, 1997; Woodfine, 2009; Snapp et al., 2010). In addition to that recent yields of some crops have remained stagnant causing food shortages and malnutrition (The Montpellier Panel, 2013).

Benefits of intensification in Asia were quite visible, especially increases in crop yields and farm incomes, during the green revolution. However, the negative environmental externalities from the practices have reoriented the focus to the sustainability aspects of intensification (Jhamtani, 2010). Sustainable intensification involves application of multiple inputs, technologies and practices in an integrated way to increase agricultural productivity while simultaneously increasing the contribution to natural capital and environmental services (Pretty, 1997; Godfray et al., 2010). Sustainable intensification practices (SIPs) cover areas like crop improvement, soil conservation, conservation agriculture, integrated pest management, horticultural, livestock and fodder management and aquaculture (Pretty et al., 2011). In addition, they are aimed at maintaining biodiversity, reducing soil erosion, reducing impact of drought, and limited use of inorganic fertilizers and

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agro-chemicals to avoid pollution (Vanlauwe and Giller, 2006; Giller et al., 2011; Pretty et al., 2011).

Determinants of acceptance and use of agricultural technologies have been widely highlighted by the literature on technology adoption (Teklewold et al., 2013; Manda et al., 2015; Kotu et al., 2017). These studies primarily focus on socio-economic factors (e.g. age, gender, resource endowment) and bio-physical factors (e.g. soil, topography) to explain adoption decisions (Manda et al., 2016; Teklewold et al., 2013). In contrast, socio-psychological farmer features such as motivations and perceptions that could influence adoption have received less attention in the adoption literature. However, few studies (e.g. Greiner and Gregg, 2011; Zabala et al., 2017) have highlighted the importance of motivational aspects. For instance, Greiner and Gregg (2011) found that economic, conservation, lifestyle and social motivations influenced farmers' adoption of conservation practices in Australia. Veisi et al. (2017) in Iran identified economic, health, safety, and environment motivations as factors affecting farmers' decision-making on adoption of organic farming. In Mexico, personal, environment, and economic motivations influenced the probability to adopt silvopastoral system (Zabala et al., 2017).

Furthermore, studies on motivations (e.g. Greiner and Gregg, 2011; Veisi et al., 2017) largely focused on motivations that drive adoption of individual technologies without examining the effect of these motivations on farmers' decision-making regarding interacting inputs, technologies and practices in the whole-farm context. The objective of this study is to bridge this gap by exploring farmer motivations and perceived impediments that could influence adoption of SIPs and to assess the effect of motivations on farmers' decisions to adopt SIPs, using farm household data from northern Ghana. Farmers in northern Ghana face similar agro-ecological and socio-economic challenges as most farmers in SSA. Therefore, we expect results from this study to aid policymakers and researchers design better extension strategies that can stimulate adoption of SIPs within SSA. We also expect that the findings would contribute to the paucity of literature on how motivations influence farmers' decisions to adopt agricultural technologies and farming practices.

2. Conceptual framework

The literature on technology adoption stipulates three adoption decision paradigms: innovation-diffusion-adoption, economic constraint, and adopter-perception (Adesina and Zinnah, 1993). Innovation-diffusion-adoption is anchored on the premise that adoption decisions are based on assembling information, revising the information and re-evaluating decisions (Feder et al., 1985). The demerit of this paradigm is that it failed to incorporate characteristics of the individual. The economic constraint paradigm is based on the concept of utility maximization and assumes that individuals will adopt a technology when utility associated with the new technology is greater than the existing utility. However, the concept ignored intangible factors such as personal preferences and objectives (Adesina and Zinnah, 1993; Negatu and Parikh, 1999). Adopter-perception is based on the idea that individuals adopt innovative technologies when they acknowledge the need to do so. This paradigm incorporates influences of personal and

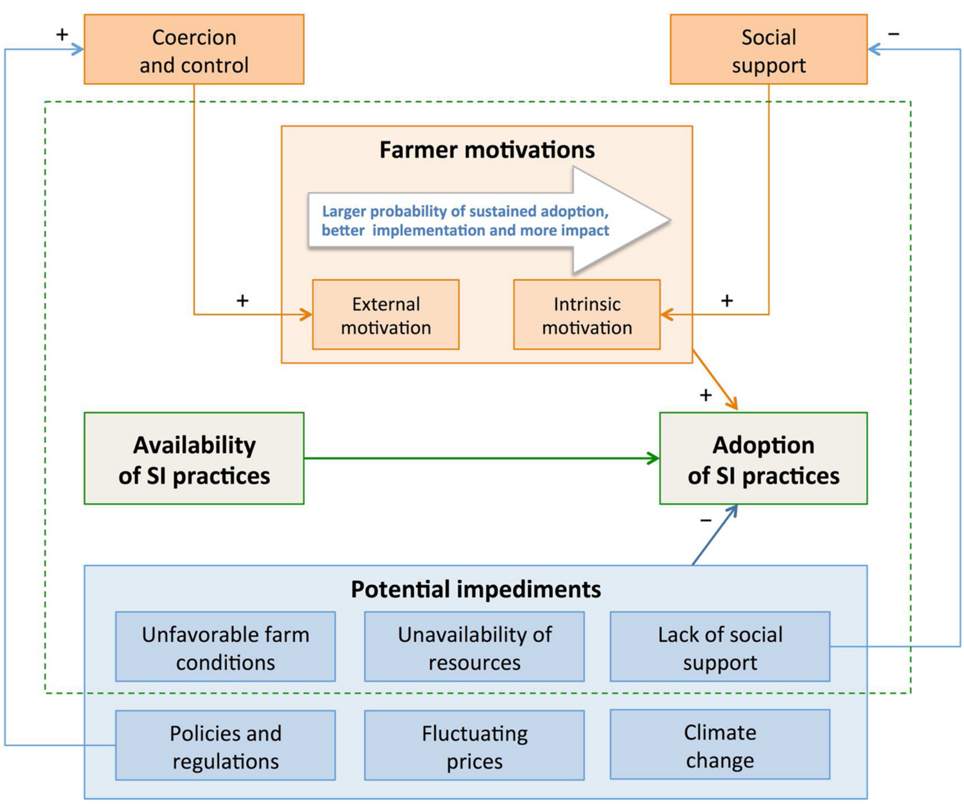

Fig. 1. Conceptual framework of farmers' motivations and perceived impediments to adoption of SIPs. The orange boxes indicate motivational aspects, the green boxes relate to available farm technologies and practices, while the blue boxes represent the internal and external impediments. The dashed line indicates the farm system boundary. Arrows indicate positive or negative influences. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

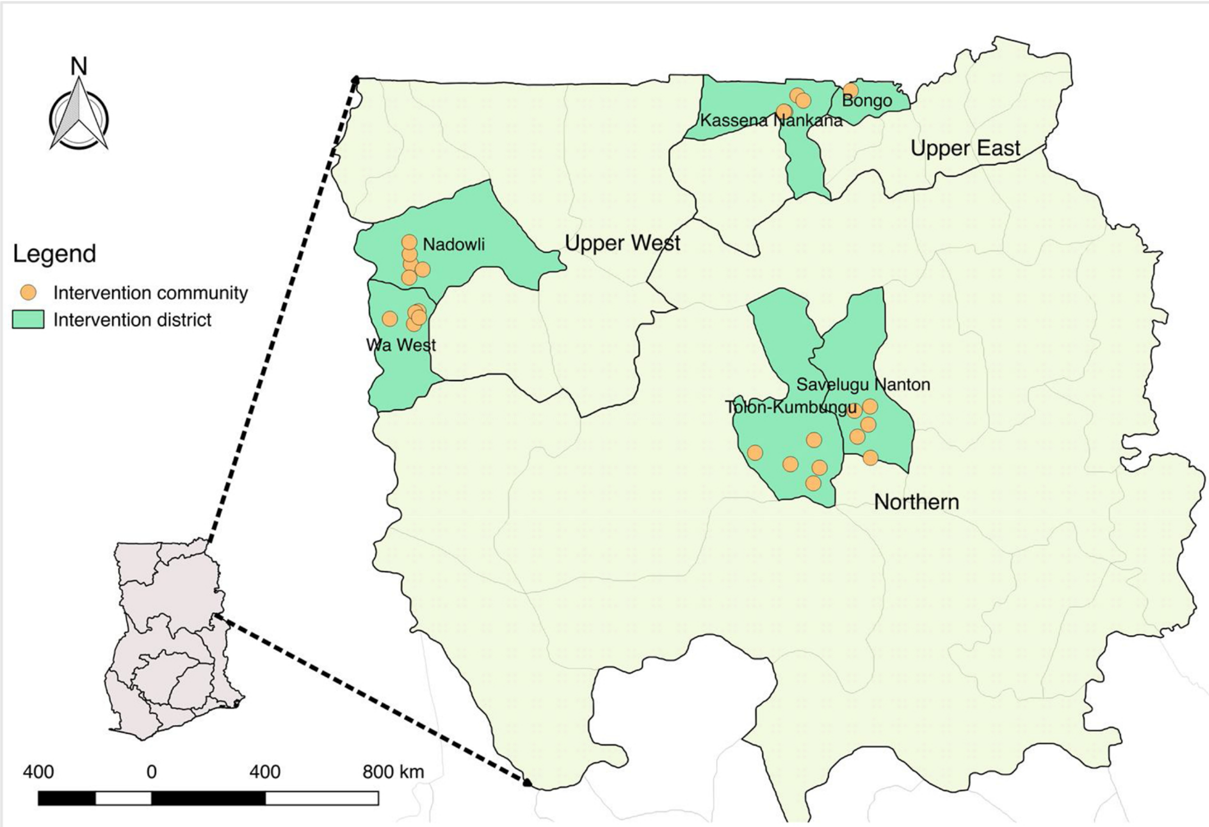

Fig. 2. Africa RISING intervention districts and communities in northern Ghana. (Use colour).

physical factors such as land and institutions (Ervin and Ervin, 1982; Lynne et al., 1988).

The first two paradigms on technology adoption have been extensively discussed in the adoption literature as opposed to the last paradigm, with attention lacking, especially for the effects of personal or socio-psychological factors on decisions to adopt new agricultural technologies. Socio-psychological issues such as motivation are considered as important factors that influence human behaviour and performance (Pannell et al., 2006). Motivations could influence farmers' adoption decisions (Pannell et al., 2006), and reflect goals and aspirations that farmers wish to achieve in the long-run (Farmar-Bowers and Lane, 2009). Similarly, the same motivations drive producers to become farmers in the first place (Watt and Richardson, 2007). Further, motivation is often categorised as either intrinsic or extrinsic (Ryan and Deci, 2000). Intrinsic motivation is anchored on interest and satisfaction derived from activities, while extrinsic motivation is based on outcomes and rewards that are separated from the core activities, and characterised by external control and coercion (Prager and Posthumus, 2010). Chirkov et al. (2003) and Moller et al. (2006) argued that the probability of adoption and sustained use of technology, and of good implementation is enhanced when motivation is intrinsically driven. Furthermore, farmers' desire to achieve their future aspirations or goals can be constrained by numerous factors, such as lack of resources, policies and regulation, low returns on investment, climatic condition, risk and uncertainty, etc. (Marra et al., 2003; Pannell et al., 2006). As it is entirely personal, the perception about these constraints varies among farmers (Anderson et al., 1988).

Fig. 1 depicts the pathways via which motivations can influence farmers to adopt SIPs. It is expected that external drivers like policy and regulations, climate change and price volatilities can coerce or force farmers into adopting SIPs, which would be classified as extrinsic motivation. In addition, social influence or supports from family, relatives or the community can influence adoption of SIPs. Nevertheless, impediments that are internal to the farm system such as unfavorable farm conditions (e.g. soil characteristic), unavailability of key resources or farm inputs and lack of social support are expected to negatively affect the intrinsic motivation for sustainable intensification and thereby reduce the probability of adoption of SIPs.

3. Material

3.1. Description of study area

Ghana is divided into ten regions. The northern part of the country consists of Northern region, Upper West region, and Upper East region (Fig. 2). The regions are situated within the Guinea (Northern and Upper West) and the Sudano-sahellian (Upper East) agroecological zones. Compared to other regions of Ghana, the three northern regions have higher poverty rates (WFP, 2012; GSS, 2014; Cooke et al., 2016), a higher degree of crop failure, a higher drought risk, lower adaptive capacity, and therefore a high degree of farmer vulnerability (Antwi-Agyei et al., 2012). Furthermore, the regions are characterised by erratic rainfall patterns and high temperatures (WFP, 2012). The soils in the regions are shallow with underlying iron-pans that make crop production difficult (Quansah, 2004). The majority of the inhabitants, who are smallholder farmers, cultivate cereals (e.g. maize), legumes (e.g. beans) and vegetables (e.g., cabbage), as well as raise large (e.g., cattle) and small ruminants (e.g., sheep, goat), poultry, and pigs (GSS, 2014).

To help improve the cereal-legume based farming systems in the regions, the International Institute of Tropical Agriculture (IITA) under the program called Africa Research in Sustainable Intensification for the Next Generation (Africa RISING) in 2012, disseminated three sustainable intensification practices (SIPs) across some districts in the regions as part of the numerous project activities conducted. The SIPs were (1) improved maize varieties; (2) cropping system strategies; and (3) combined practices (SIPs). In addition, farmers were trained on good agronomic practices such as correct timing and application of organic and inorganic fertilisers, weed control, pesticide application, and row planting.

The first SIP, improved maize varieties[1] (e.g., drought-tolerant maize, extra-early maize, and Striga[2] (*Vigna unguiculata*)-resistant maize), was aimed at improving household food security and farm incomes through increased crop yields (Larbi et al., 2014). It was also targeted at helping farmers adapt to climate changes. For example, the extra-early maize varieties mature very early (in approximately 60 days) and allow farmers to escape dry spells and frequent droughts. The second SIP consists of various cropping system strategies (e.g. cereal-legume strip cropping, cereal-legume crop rotation). This was aimed at enhancing the ecosystem services of the cropping system: nitrogen-fixation, pest reduction, weed control and carbon sequestration (Altieri, 1999; Jhamtani, 2010; Snapp et al., 2010). Soil fertility, soil organic matter content, and soil water retention capacity are improved when crop residues from maize and legume are incorporated into the soil (Vanlauwe et al., 2014). The second SIP was also directed at reducing costs of inorganic fertilizers and at controlling weeds, such as Striga, a major weed found in the regions.

The third SIP combined the other two SIPs and was targeted at achieving all the benefits of the first and second SIPs. Several studies have shown the importance of adopting both improved maize varieties and cropping system strategies. For example, it improves soil productivity, increases crop yields, helps reduce the use of inorganic fertilizer and agrochemicals, helps control soil erosion, reduces weed population, etc. Kotu et al. (2017) found that farmers who adopted two or more sustainable intensification practices in Ghana attained higher yields compared to those who adopted a single technology.

3.2. Data

The dataset used in this analysis was derived from a cross-sectional survey of farmers who have adopted SIPs since 2012. The survey was carried out between February and March 2016 within AfricaRISING project intervention districts Savelugu-Nanton and Tolon-Kumbungu in the Northern region, Kassena-Nankana and Bongo in the Upper East region, and Wa-West and Nadowli in the Upper West region. A multistage sampling procedure was used to collect data from 290 farm households that have adopted one or more SIPs. First, two to three communities were purposively selected based on the size and the number of farmers in each community. Second, twenty to forty farm households were randomly sampled from each community. A structured questionnaire was used to elicit information on socio-economic characteristics, soil characteristics, motivation and impediment. Questions on motivation (see Appendix, Fig. A1) and perceived impediments (see Appendix, Fig. A2) were adapted from studies by Marra et al. (2003); Maybery et al. (2005), and Greiner and Gregg (2011). Respondent farmers indicated their response to each statement using a pre-defined five-point Likert-scale ranging from 1 = strongly disagree to 5 = strongly agree.

4. Methods

4.1. Identification of factors of motivation and perceived impediment to adoption of SIP

We used explorative factor analysis (EFA) to identify intrinsic factors that motivate farmers to adopt SIPs. EFA identifies latent or unobserved variables that explain the proportion of variance shared among two or more observed variables (Field, 2013; Kabacoff, 2015). Before EFA, responses on motivation and impediment that resulted in low inter-correlation ($r < 0.3$) were deleted, resulting in 278 responses (i.e. 96% response rate). In addition, we did not detect any extreme correlation ($r > 0.8$) in the data set. The data was also appropriate for EFA: a good Kaiser–Meyer Olkins (KMO > 0.7) was obtained for motivation (0.81) and impediment (0.77) respectively, and the analysis showed significance of the Barlett test for motivation ($\chi^2(66) = 1192.5$, $P < 0.05$) and impediment (χ^2 (36) = 730.281, $P < 0.05$).

To interpret the motivational factors, we used the Varimax rotation since we expect the factors to be uncorrelated. We calculated the Cronbach alpha value to determine the degree of cohesion within each factor, and the violin plots with Tukey multiple comparison test to compare the derived factors of motivation and impediment within and between regions (Park et al., 2014; Hintze and Nelson, 1998). We used parallel analysis to confirm the number of factors of motivation and impediments that had to be extracted (Kabacoff, 2015).

4.2. Effect of factors of motivation on farmers' decisions to adopt SIPs

We used the multinomial logit model (Madalla, 1983) to examine the effect of motivational factors on farmers' decisions to adopt SIPs. Several studies have used models such as probit, logit, or bivariate probit to examine the effects of socio-economic factors on farmers' decisions to adopt agricultural technologies (Andvig, 2000). The advantage of the multinomial logit over other models is that the multinomial model allows analysis of decisions across several categories, such as cropping system strategies, improved maize varieties, and the combined practices (Nkamleu and Kielland, 2006).

We assumed that a respondent farmer, *i*, face a choice between three SIPs(s): cropping system strategies, improved maize varieties, and the combined SIPs, thus $s = 1, 2, 3$ (Nkamleu and Kielland, 2006). To examine how factors of motivation and socio-economic factors (Z) influence farmers' decisions to adopt SIPs (s), the choice probability is defined by the multinomial logit model (1). To estimate the model, we normalized on one category by equating it to one. In our analysis, we used cropping system strategies as a reference category. The parameters, $\beta_{i's,}$ are estimated with the models below.

$$\mathrm{P(Y{=}\ s)} = \frac{e^{\beta_i Z}}{1+\sum_{j=2}^{S} e^{\beta_j Z}}\ \text{for}\ s \neq 1 \tag{1}$$

$$\mathrm{P(Y{=}1)} = \frac{1}{1+\sum_{j=2}^{S} e^{\beta_j Z}}\ s = 1 \tag{2}$$

Several socio-economic variables have been shown to influence farmers' adoption of agricultural technologies in northern Ghana (Doss and Morris, 2001; Kotu et al., 2017). We considered age, gender and educational level of the household head, total number of livestock owned, household size, land size, distance to the market, access to extension services, agro-ecological zone, and quantity of inorganic fertiliser in the model. We included the derived factors of motivations

[1] These are open pollinated improved maize seeds developed by IITA in conjunction with the Savanna Agricultural Research Institute (SARI).

[2] This is a witch weed that competes with other plants for soil nutrients.

Table 1
Percentage of respondent farmers applying sustainable intensification practices (SIPs) in three regions (Upper West, Upper East and Northern) in the north of Ghana.

SIPs	Upper West region (n = 96)	Upper East region (n = 70)	Northern region (n = 112)
Cropping system strategies only	33%	36%	7%
Improved maize variety only	45%	26%	37%
Combined practices (improved maize variety and cropping system strategies)	22%	38%	56%
Total using improved maize varieties (2 + 3)	67%	64%	93%
Total using cropping system strategies (1 + 3)	55%	74%	63%

as independent variables in the analysis. A description of the explanatory variables used and their hypothesized effect on farmers' adoption of SIPs are briefly discussed below.

Age, measured in years, was expected to reduce the adoption of SIPs. Due to the accumulated experience with regards to production technologies, physical and social capital by older farmers, they often tend to be less likely to adopt modern agricultural technologies compared to younger farmers, who often times tend to be more flexible to agricultural innovations (Kassie et al., 2013). The gender of the household head, measured as a dummy variable, influence farmers adoption of agricultural technologies in Ghana. Doss and Morris (2001) showed that female farmers in Ghana are less likely to adopt new agricultural practices due to limited access to resources such as land, education and extension services. We therefore expected adoption of SIPs in male headed households to greater than those of the female compatriots.

Educated household members (measured as number of years of schooling) were expected to be aware of benefits associated with SIPs, since they are be able to acquire, process and use information easily (Pender and Gebremedhin, 2007). Hence, we hypothesized a positive relationship between education and SIPs. Livestock (measured in Tropical Livestock Units) plays an essential role in most farms in northern Ghana. For instance, they are used for ploughing, for carting produce between homestead and market, for conveying inputs from the market, and sometimes serve as security (i.e. sold to raise money) during emergencies. Hence, we anticipated a positive relationship between adoption of SIPs and livestock ownership.

Household size (measured in number) was used as a proxy for available labour in the household. We expected that the larger the household size, the more labour will available for crop production, and therefore the more likely the household will adopt SIPs (Pender and Gebremedhin, 2007). We therefore hypothesized that household size would correlate positively with adoption of SIPs. Access to agricultural extension services (measured as a dummy variable) is expected to influence adoption of agricultural technologies (Kassie et al., 2013). This is because through agricultural extension services, farmers tend to become aware of new technologies and learn how to implement them in their fields. We therefore anticipated a positive correlation between access to extension services and SIPs.

Farm size (measured in hectares) can influence the adoption of new technologies (Kassie et al., 2013). For example, farm households with larger farm size can decide to allocate more land to new practices such as the combined SIP. This means that households with larger farm size would be more inclined to adopt SIPs compared with those with less land. Nevertheless, households with larger farm size might use less intensive methods than those with less farm size (Kassie et al., 2013). Overall, we anticipated that households with larger farm size will be more likely to adopt the SIPs compared to households with smaller farmer size. Further, the longer the distance to markets, the less likely that farmers would adopt SIPs (Kassie et al., 2013).

The three regions are characterized by two agro-ecological zones (measured as dummy variable), namely, the Guinea savanna zone (comprising the Northern region and Upper West region) and the Sudan savanna zone (Upper East region). Farmers in the Sudan savanna zone are more prone to drought than those in the Guinea savanna zone (Antwi-Agyei et al., 2012; WFP, 2012). Therefore, we expected farmers in the Sudan savanna zone to adopt more of improved maize varieties (e.g. drought tolerant maize or extra-early maturing maize variety) and the combined SIPs. Further, we expected the agroecological zone to partially reflect soil characteristics that could explain preferences to certain crops and practices. For example, cereal crops such as millet and sorghum, which require less rains and can withstand less fertile soils, are widely grown by farmers in the Upper East region compared to those in the Northern region and the Upper West region. Therefore, we expected farmers with poor fertile soils to adopt soil-enhancing technology such as the combined SIPs.

There might also be direct simultaneity between amount of organic or inorganic fertiliser applied and adoption of improved maize varieties (Smale et al., 1995). Failure to control this can bias the result estimates. Therefore, we followed Manda et al. (2016) by using the average rate of fertilizer application at the community level to prevent biasing the estimates. Furthermore, we included the factor scores of the identified motivational factors as independent variables in the analysis. We hypothesized that these identified factors may have positive or negative relationship with the SIPs.

One underlying assumption of the multinomial logit is Independence of Irrelevant Alternative (IIA). This means that choosing one alternative level (e.g. improved maize varieties) over another should not be influenced by the presence of another choice (e.g. combined SIPs) (Hilbe, 2009). We used Hausman and McFadden tests to confirm IIA. Further, interpreting logit coefficients is tedious, hence, we adopted the relative risk ratio (i.e. exponentiated value of the logit coefficients) approach to ensure easy interpretation of the coefficients (Hilbe, 2009).

The entire analysis was conducted with R version 3.3 (R Core Team, 2016). Factor analyses was conducted using the "psych" package (Revelle, 2011).Visualization of Likert scores was conducted using the DevTools package (http://jason.bryer.org/likert/), and the multinomial logit was estimated using the "nnet" package (Ripley and Venables, 2016) and the "mlogit" package[3] (Croissant, 2013).

5. Results and discussion

5.1. Use of sustainable intensification practices

The adoption of SIPs by respondent farmers varied across the three regions (Table 1). The adoption rate of improved maize cultivars was the highest in the Northern region (93%), and most farmers combined these with cropping system strategies (56%), so that the percentage of farmers only practicing cropping systems strategies was low (7%). In the Upper East Region, the percentage of farmers applying cropping system strategies was the highest among the three regions while the percentage of applying improved varieties is the lowest (Table 1). In Upper West Region, relatively high percentage of farmers adopt improved varieties only.

[3] The "mlogit" package helped to test assumption of IIA.

Table 2
Factor loadings of motivational items in the three-factor model resulting from explorative factor analysis.

Motivation items	*Factor 1* Personal satisfaction	*Factor 2* Eco-diversity	*Factor 3* Eco-efficiency
Personally rewarding (non-financial)	**0.92**	0.01	0.00
Food satisfaction	**0.60**	−0.06	0.11
Easy to be adopted by other farmers	**0.59**	0.06	−0.01
Improve household nutrition due to nutritional diversity	−0.02	**0.80**	−0.04
Lower input use because of system diversification	−0.09	**0.62**	0.24
Promote cereal and legume cultivation	0.19	**0.59**	−0.05
Improvement of land productivity	0.10	−0.05	**0.87**
Improvement of the environment	−0.09	0.08	**0.82**
Increase farm income	0.05	0.13	**0.40**
Important for improving crop yields	0.39	0.35	−0.01
Less labor as compared with old practices	0.25	0.30	0.12
Important for reducing soil erosion on the field	0.22	0.37	0.20
Eigen values	2.06	2.01	1.09
Proportion of variance	0.17	0.17	0.16
Cronbach's alpha (α)	0.73	0.73	0.75

The term 'eco' denotes ecological. Factor loadings > 0.4 are highlighted in bold.

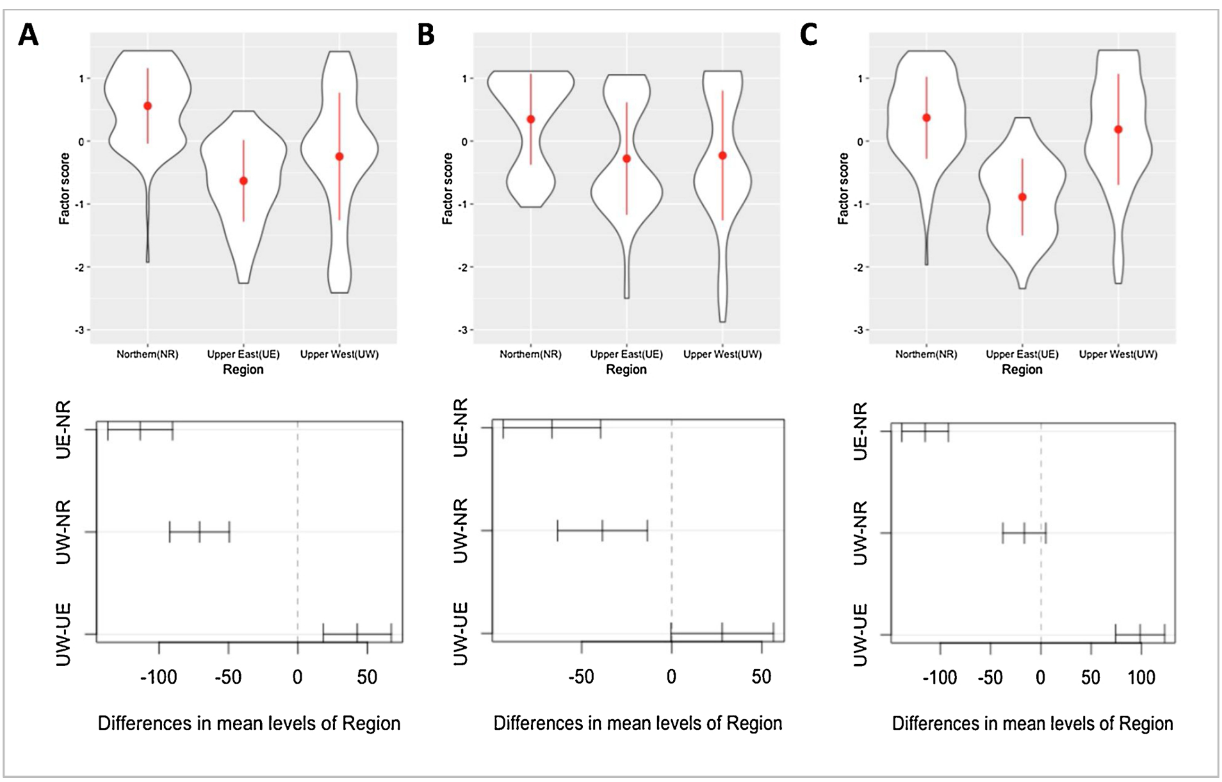

Fig. 3. Regional comparison of *Personal satisfaction* (A), *Eco-diversity* (B) and *Eco-efficiency* (C). The point-range denotes mean ± standard deviation. The lower section represents multiple comparison of similar factors of motivations across regions (the bar line represents 95% confidence interval of the differences). UW denotes Upper West region, UE represents Upper East region, while Northern region is represented by NR.

5.2. Motivational factors

Farmers' ratings of motivations were highest in the Upper West Region followed by Upper East and Northern regions respectively (Fig. A1). Nonetheless, similarities in ratings were observed among the regions. For example, respondent farmers in the Upper East and the Upper West regions rated the item 'the SIPs are easy to be adopted by other farmers' equally, whereas respondent farmers in the Upper East and the Northern regions rated the item 'the SIPs demand less labour input compared with old practices' the same.

EFA on motivation produced a three-factor model (Table 2). The factors explained 50% of the variance within the data set. The Cronbach alpha values revealed a strong coherence within each factor with 0.73 each for factor 1 and factor 2, and 0.75 for factor 3. The first factor

Table 3
Factor loadings of impediment items in the three-factor model resulting from explorative factor analysis.

Impediment items	*Factor 1* Uncertainty	*Factor 2* Absence of social support	*Factor 3* Resource constraints
Lack of future role model to continue the implementation	**0.50**	−0.14	0.17
Not sure of what will be the future gains of SIPs	**0.77**	0.07	−0.02
Lack of farmlands in the future to implement the technologies	**0.60**	−0.07	0.01
The fear to try new things	**0.76**	0.01	0.04
Lack of support from family/ relatives	−0.03	**0.72**	0.22
Lack of community support	0.11	**0.79**	−0.07
Financial constraints	0.03	0.05	**0.61**
Lack of knowledge about future practicability	0.03	0.03	**0.82**
Concern with what the community might think about me	0.38	0.24	−0.07
Eigen value	2.00	1.31	1.22
Proportion of variance	0.22	0.15	0.14
Cronbach's alpha (α)	0.75	0.76	0.71

Factor loading > 0.4 is highlighted in bold.

captured issues of 'ease of implementation', and 'satisfaction', and was therefore called '*personal satisfaction'*. This factor suggests that the first group of respondent farmers were motivated by the broader livelihood benefits associated with the SIPs rather than pure economic/financial reasons. This result is consistent with the findings of Zabala et al. (2017), who found that these types of farmers are often more interested in self-sufficiency rather than external payment or income.

The second factor was denoted '*eco-diversity'* and represented items related to 'crop diversity', 'lower input use attributed to farming system diversification', and 'improved household dietary diversity', suggesting that the second group of respondent farmers were more motivated by the diversity of crops and the nutritional benefits associated with adopting the SIPs. Finally, the last factor, '*eco-efficiency'*, captured issues of 'environment improvement', 'land productivity', and 'increase income', indicating that the combination of economic/financial and environmental benefits could be a motivating factor for adopting SIPs. This finding supports previous studies (e.g. Maybery et al., 2005; Greiner and Gregg, 2011) that found an integrated perspective on financial and environmental performance influencing farmers' adoption behaviours.

Differences in the mean factor score and the distributional pattern (i.e. shape, bumps and peak) for motivation types were observed between regions (Fig. 3), suggesting that the levels of motivation for the various perspectives of satisfaction, diversity and efficiency among respondent farmers varied within and between the regions. For example, the distributional patterns for *personal satisfaction* significantly differed between the three regions (Fig. 3A). Conversely, for eco-diversity (Fig. 3B) the means and distributional patterns for the Upper West and the Upper East (UW-UE) regions are similar, suggesting that farmers in these regions are motivated by the same reasons. However, the mean and distributional patterns for the Northern region differ from that of Upper West and Upper East regions.

5.3. Perceived impediment factors

The rating scores for impediments were systematically highest in the Northern Region followed by Upper East and Upper West regions (Fig. A2). However, similarities in the rating scores were also observed between the regions. Respondent farmers in all regions rated the items 'concern with what the community might think about me' equally, whereas no significant differences were found between Upper West and Upper East and between Northern and Upper West regions for the item 'uncertainty about the future gain of adopting the SIPs'.

EFA on impediments produced a three-factor model, which explained 51% of the total variance within the data set (Table 3). The Cronbach alpha values revealed a strong cohesion within each factor with factor 1 possessing an alpha value of 0.75, 0.76 for factor 2 and 0.71 for factor 3. The first factor, *'uncertainty'*, represented constraints based on the view that SIPs may not be practicable in the future. This factor included social forms of uncertainty such as 'I am concerned with what the community might think about me', besides unfavorable weather conditions and unstable commodity prices. This finding is consistent with the results of Greiner and Gregg (2011), who found that perceived uncertainty about the future influenced farmers' adoption of conservation practice in Australia.

The second factor was related to social environment (i.e. lack of support from community, relatives and friends) and therefore we termed this factor as '*absence of social support*'. This factor indicates that the second group of respondent farmers perceived the absence of social support as an impediment to the adoption of SIPs. This finding supports the results of Jordan (2005), who found that absent social support influenced farmers adoption of sustainable agriculture practices in Georgia, USA. The final factor captured issues related to the lack of capacity building and finance, and therefore we called it '*resource constraints*'. Respondent farmers that scored high on this factor perceived lack of resources constraining their adoption of SIPs.

Differences in distributional patterns (i.e. shape, bump and peak) were observed for the impediment factors between the regions, indicating that the levels of perceived impediments among respondent farmers in each region varied. By contrast, when similar factors of impediment are compared between regions (Fig. 4), no statistically significant differences in mean factor scores were observed for *uncertainty* and *resource constraints*, with the exception of a difference in *resource constraints* between Upper West and Upper East regions. Also, statistically significant differences in mean factor scores were observed for *absence of social support* across the three regions.

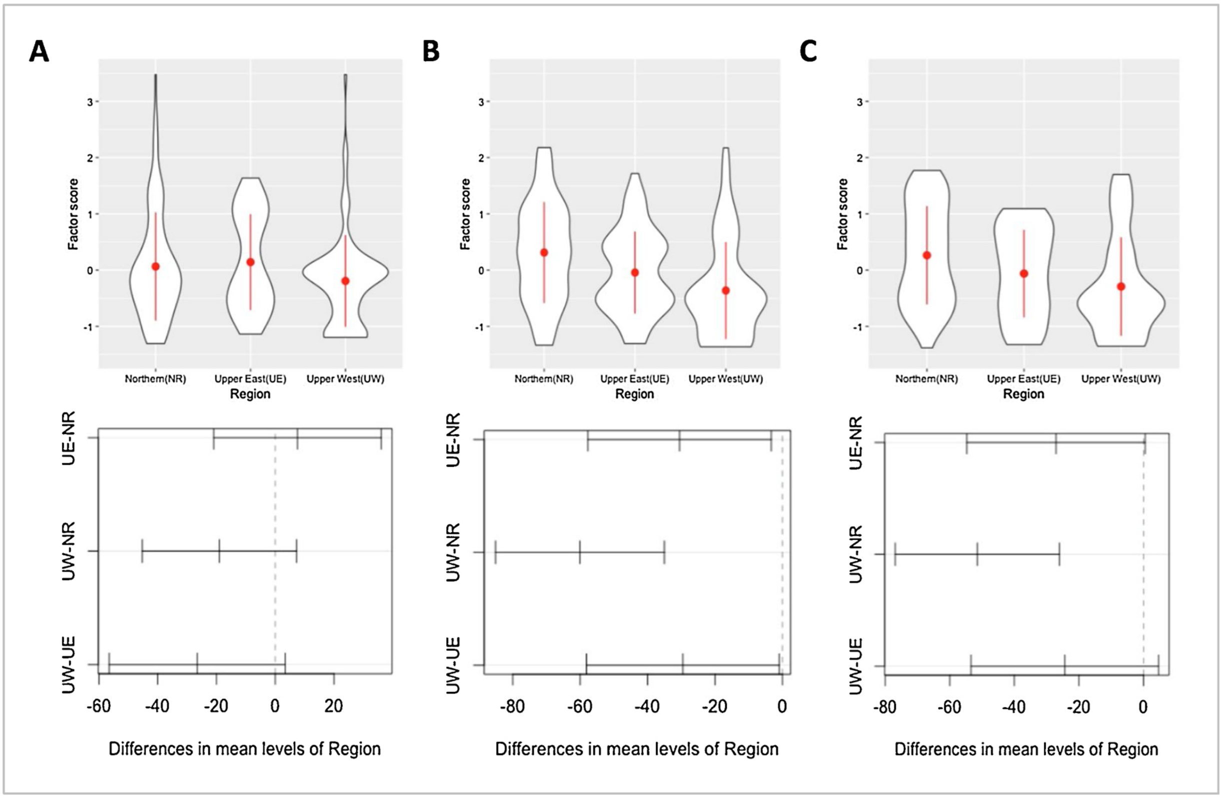

Fig. 4. Regional comparison for *Uncertainty* (A), *Absence of social support* (B) and *Resource constraints* (C). The point-range denotes mean ± standard deviation. The lower section represents multiple comparison of similar factors of motivations across regions (the bar line represents 95% confidence interval of the differences). UW denotes Upper West region, UE represents Upper East region, while Northern region is represented by NR.

Table 4
Relative risk ratio estimates of choice of SIPs by respondent farmers in northern Ghana.

	Improved maize varieties		Combined SIPs	
	Coefficient	t-statistic	Coefficient	t-statistic
Male headed household	4.889***	2.024	2.512***	1.735
Age	1.016	0.201	1.042	0.618
Age square	1.000	−0.189	1.000	−0.648
Education	1.028	0.252	1.024	0.244
Household size	1.045	0.629	1.017	0.273
Farm size	0.818**	−1.969	0.932	−1.307
Extension services	1.718***	0.210	1.100	0.210
Livestock ownership	0.991	−0.960	1.005	0.857
Distance to market	1.119	0.970	1.009	0.932
Amount of fertilizer applied	0.991	−0.813	0.992	−0.813
Sudan savanna	0.177***	−1.001	0.560***	0.317
Personal satisfaction	0.408***	−2.525	0.766*	0.492
Eco-diversity	0.859	−0.563	0.928	0.746
Eco-efficiency	1.468***	1.037	0.982	0.956
Constant	0.759***	−0.117	1.455***	0.195
Number of observation(n)	277			
Log likelihood	−243.133			
Wald testχ^2(2)	52.141***			

***$P < 0.001$, **$P < 0.05$, and *$P < 0.10$. The reference SIP is cropping system strategies.

5.4. Factors motivating farmers' decision to adopt SIPs

Table 4 shows the parameter estimates for choice of SIPs by respondent farmers in northern Ghana. The preference for SIPs is expressed relative to cropping system strategies, which has a reference value of 1. Our result confirmed the assumption of IIA (χ^2 (15) = 141.93, $P > 0.05$). In addition, the Wald χ^2 test rejected the null hypothesis that the explanatory variables are jointly equal to zero, suggesting that the explanatory variables can explain variability in the adoption of SIPs.

Results showed that indeed some of the factors of motivation influenced farmers' decisions to adopt SIPs. For instance, farmers motivated by *personal satisfaction* are less likely to adopt only improved maize varieties (59%) and the combined SIPs (23%) compared to cropping system strategies (100%). The coefficients are statistically significant, which may indicate that farmers motivated by *personal satisfaction* somewhat preferred the cropping system strategies together with the improved maize varieties due to benefits associated with cropping system strategies, especially to the soil. Adoption of the SIPs may translate into increases in maize yields, which could lead to more food for the household. Furthermore, farmers motivated by *eco-efficiency* were 47% more likely to adopt improved maize varieties compared with only cropping system strategies. The coefficient is statistically significant, suggesting that farmers motivated by *eco-efficiency* may perhaps be driven more by the increases in crop yields, income and efficient fertilizer management associated with dissemination of the

SIPs. This result supports the findings of Manda et al. (2016), who found that in Zambia increased in maize yield and income influenced farmers' adoption of sustainable agricultural practices such as improved maize varieties.

In addition to the motivational factors, some of the socio-economic variables also influenced farmers' decisions to adopt SIPs. For instance, the results show that larger farm size was related to a reduction in the preference of adopting improved maize varieties relative to cropping system strategies. This finding is in line with the results of Kotu et al. (2017), who found that households that own large farm sizes are more likely to adopt cropping system strategies in the three regions. Male headed households were much more likely to adopt improved maize varieties and the combined SIPs. The coefficients were statistically significant, indicating that male-headed households may have more access to resources compared to female-headed household. This is consistent with the findings of Doss and Morris (2001) who found that in Ghana, women's lack of access to resources (e.g., education, extension services) prevent them from adopting new agricultural practices.

Results also show that for a one-unit increase in extension services, the relative risk ratio of adopting improved maize varieties increased by 72% for improved maize varieties and 10% for the combined SIPs. This result underlines the essential role extension services play in promoting agricultural technologies via education and training of farmers on good agronomic practices, as well as linking farmers to markets (Adegbola and Gardebroek, 2007). Finally, the result shows that farmers in the Sudan savanna zone were less likely to adopt only improved maize varieties (82%) compared to their compatriots in the Guinea savanna zone. This finding is not surprising because the dominant crops grown by farmers in the zone are millet, sorghum, and legumes, although studies (e.g., Ellis-Jones et al., 2012) suggested that the cultivation of maize is increasing.

Overall, our findings have several implications for future research targeted at spurring adoption, adaption, and ownership of agriculture technologies and practices among farmers. For example, our results that personal satisfaction and eco-efficiency influenced adoption indicate that insights or inputs from social (e.g. economists) and natural (e.g. environmentalist) scientists would be needed in developing agricultural innovations such as SIPs. To understand also unanticipated consequences in relation to for example gender relations, it would be essential to bring together different disciplines to explore potential trade-offs related with the dissemination and development of agricultural technologies and practices. Such an initiative would help in developing solutions to mitigate unwanted outcomes.

6. Conclusion

Sustainable intensification practices can play an essential role in ameliorating challenges that cause low crop yields and farm incomes and can support adaptation to climate change. These challenges are currently faced by many smallholder farmers in developing countries, in SSA. Most previous adoption studies have focused on how socio-economic factors influence adoption of new agricultural technologies with limited emphasis on how socio-psychological issues such as motivations influence farmers' adoption and decision-making. This study contributes to the literature by identifying the motivational factors and perceived impediments that influence adoption of SIPs and whether identified motivations affect farmers' decisions to adopt SIPs, using sample data collected from farm households in northern Ghana.

Findings showed that motivational factors differed between the three study regions, with a stronger importance of *personal satisfaction* and *eco-diversity* in the Northern region than in Upper East and Upper West regions. The distributions of scorings for *personal satisfaction* within the regions was different, but for *eco-diversity* similar distributions were observed for all three regions. The impediment factors of *uncertainty* and *resource constraints* were similarly experienced among farmers in the three regions, but the *lack of social support* was a more important factor in the Northern region than in Upper East and Upper West. These trends in regional differences in motivational and impediment factors suggest that to spur adoption of SIPs across the regions, both general and regional specific dissemination strategies need to be developed and employed in disseminating SIPs, instead of the conventional approach where similar disseminating strategies are used in all three regions. Results also showed that personal satisfaction and eco-efficiency positively correlated with the adoption of SIPs, indicating that dissemination strategies that focus on these attributes of SIPs can be used to spur adoption. Finally, findings from this study suggest that improvements in extension services would motivate farmers' adoption of improved maize varieties.

The current study focused on the cereal-based farming system in the region. However, it will be interesting to extent such analysis to other improved agricultural practices (e.g. soil and water management) and farming systems (e.g. legume-based, livestock) in the region. Also, since farmers' adoption of technology varies significantly across time and space, it will be essential in the future to use panel data to assess whether intrinsic motivation changes across time and space. Nonetheless, this study showed that motivational factors should be considered systematically in combination with socio-economic farm features and external drivers to inform on-farm innovation processes and supporting policies.

Declaration of Competing Interest

The author(s) declare(s) that there is no conflict of interest.

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Appendix A

Table A1

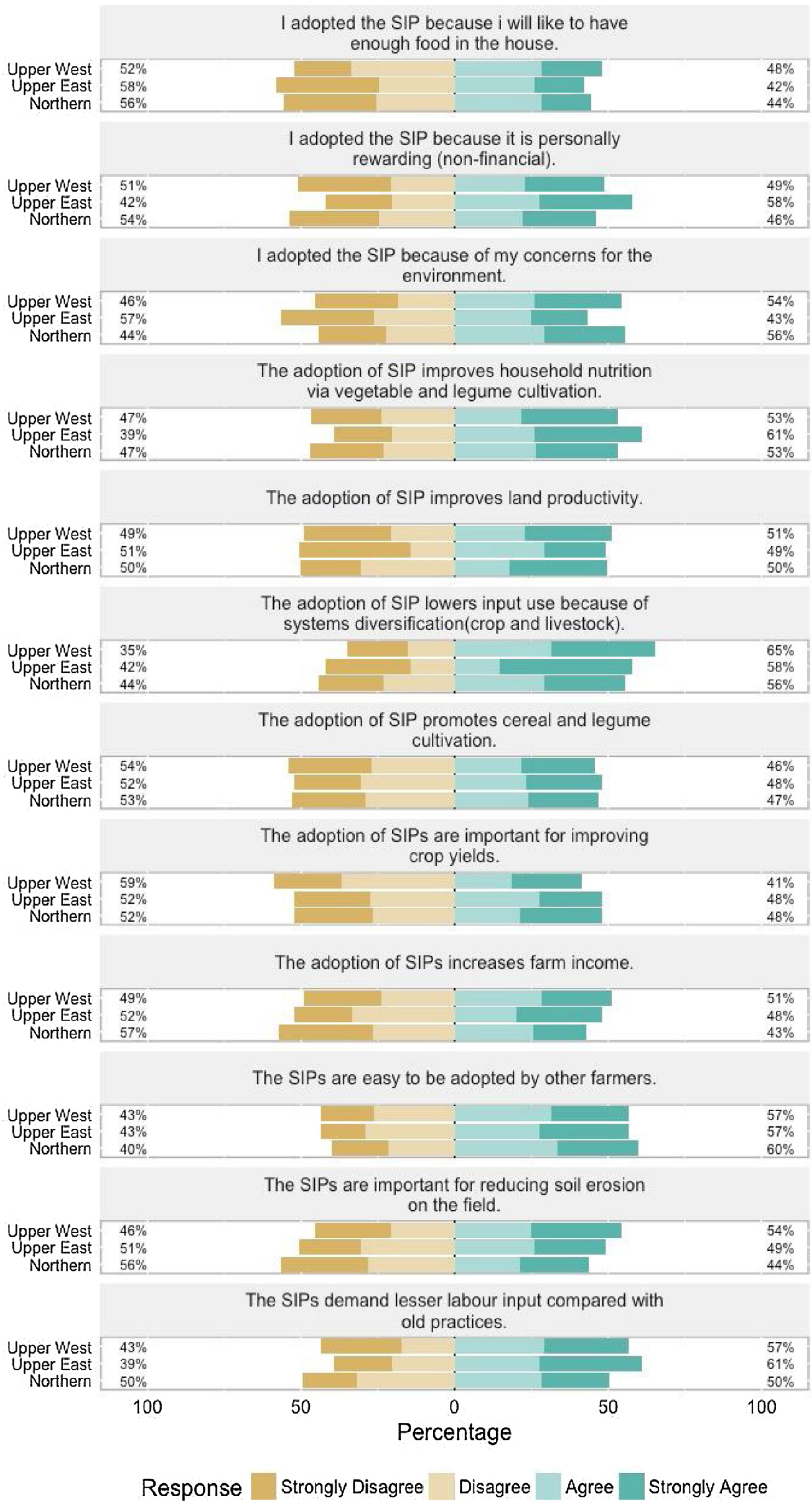

Fig. A1. A comparison of motivational response rating across the three northern regions of Ghana.

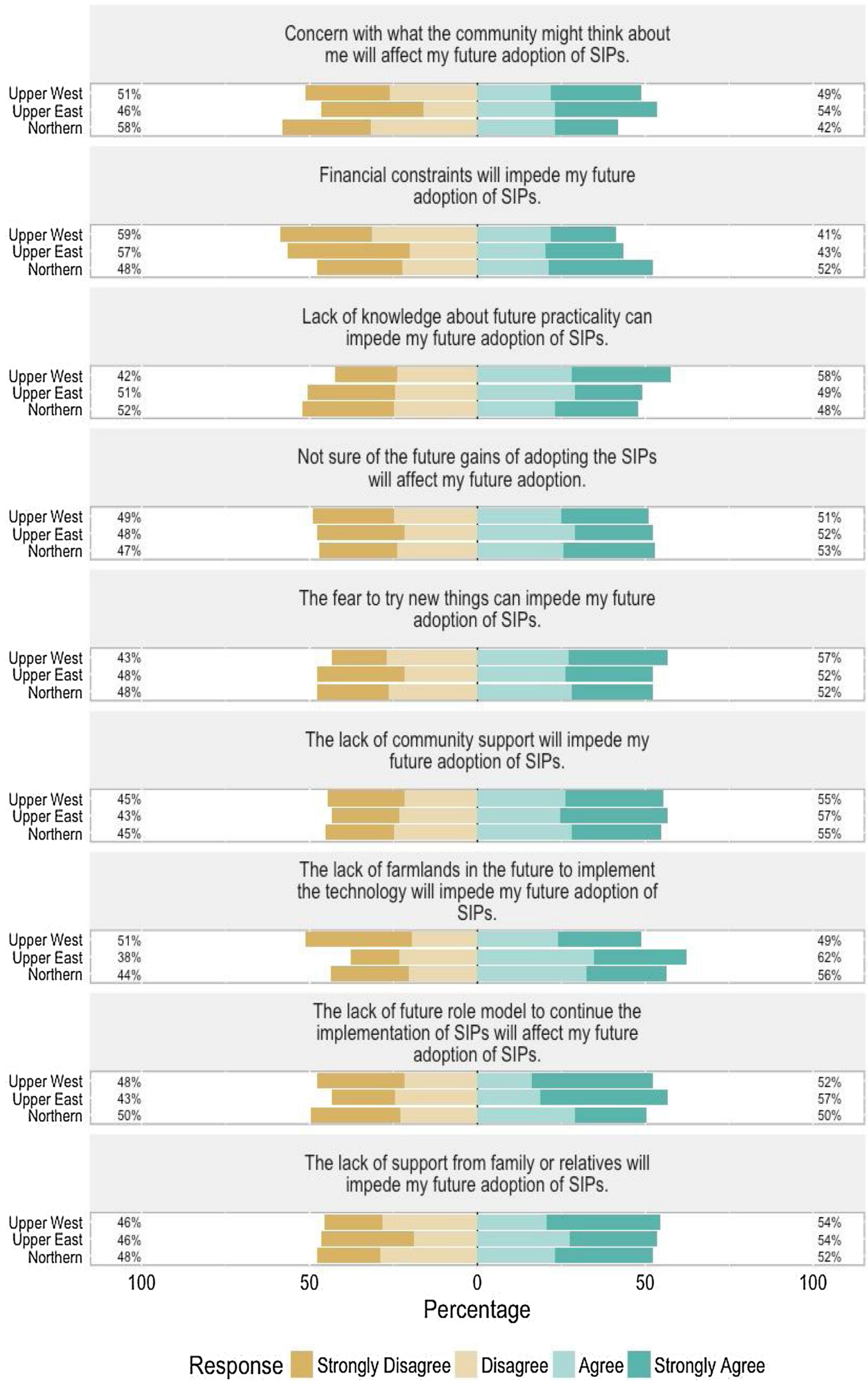

Fig. A2. A comparison of perceived impediment response rating across the three northern regions of Ghana.

Table A1
Parameter estimates for choice of SIPs by respondent farmers.

	Improved maize varieties		Combined SIPs	
	Coefficient	t-statistic	Coefficient	t-statistic
Male headed household	1.587***	2.024	0.921***	1.735
Age	0.016	0.201	0.041	0.618
Age square	−0.000	−0.189	−0.000	−0.648
Education	0.028	0.252	0.023	0.244
Household size	0.044	0.629	0.009	0.273
Farm size	−0.200**	−1.969	−0.071	−1.307
Extension services	0.540***	0.210	0.095	0.210
Livestock ownership	−0.009	−0.960	0.005	0.857
Distance to market	0.113	0.970	0.009	0.932
Amount of fertilizer applied	−0.009	−0.813	−0.008	−0.813
Sudan savanna	−1.729***	−1.001	−0.579***	0.317
Personal	−0.895***	−2.525	−0.228*	0.492
Eco-diversity	−0.152	−0.563	−0.075	0.746
Eco-efficiency	0.384***	1.037	−0.018	0.956
Constant	−0.275***	−0.117	0.375***	0.195
Number of observation(n) 277				
Log likelihood	−243.133			
Wald testχ^2(2)	52.141***			

***$P < 0.001$, **$P < 0.05$, and *$P < 0.10$. The reference SIP is cropping system strategies.

Appendix B. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:https://doi.org/10.1016/j.njas.2020.100326.

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